**PR Number:** 00PR03080-01

**Previous PR Number:** 00PR03080-00
**Title:** Manufacturable Power Switching Devices

**Award Number:** N000149511302
**Modification Number:** P00007

**Short Contractor Code:** purd
**Size and Type of Business:** 5
Nonprofit-Other inc. State and Local Government/Not FCRC

**P.I. Name:** James Cooper
**Performer:** PURDUE RESEARCH FOUNDATION
HOVDE HALL THIRD FLOOR
WEST LAFAYETTE, IN 47907

**P.O. Name:** John Zolper
**P.O. Code:** NRL
**P.O. Phone:** (703) 696-2611
**Point of Contact:** Zoupena Gaylene
**Phone:** (626) 795-4571
**Grants Officer:**

**Current Award Start Date:** 29-SEP-95
**Current Award End Date:** 31-DEC-00
**P.O. Requested Start Date:** 26-JUL-00
**P.O. Requested End Date:** 26-JUL-00

**PR Type:** Administrative Modification

**Internal Coordinator(s):**
**Phone:**

**Instrument Type:** Grant
**Basis For Selection:** (baa)
**CBD Date:**

**Current Funding:**

| ACRN | APPN | SBHD | OBJ | PA RM | BCN | SA | AAA | TT | PAA | COST CODE | AMOU |
|---|---|---|---|---|---|---|---|---|---|---|---|

**OSF CODE:**
**Future Funding:**

| FY | FRC | NEG START DATE | AMOUNT |
|---|---|---|---|

**PR Status:** Approved (Active)

**Equipment Cost (Current Year):** $ 0.00

| | |
|---|---|
| **Cumulative Total Award Value:** | $10,450,000.00 |
| **Total Value of PR:** | $ 0.00 |
| **Increment Value:** | $ 0.00 |
| **Modification Negotiated Value:** | $ 0.00 |

**Grant Document Addendum**

The purpose of this PR is to provide a no cost extension for grant N000149511302 through 31 Dec 2000.

CP
11-15

**PR Number:** 00PR03080-00

**Previous PR Number:** 99PR03240-00
**Title:** Manufacturable Power Switching Devices

**Award Number:** N000149511302
**Modification Number:** P00006

**Short Contractor Code:** purd
**Size and Type of Business:** 1s
Nonprofit-Educ./Not Historically Black/State Controlled

**P.I. Name:** James Cooper
**Performer:** PURDUE RESEARCH FOUNDATION
HOVDE HALL THIRD FLOOR
WEST LAFAYETTE, IN 47907

**P.O. Name:** John Zolper
**P.O. Code:** 312
**P.O. Phone:** (703) 696-2611
**Point of Contact:** KARPUK MICHAEL
**Phone:** (303) 940-2301
**Grants Officer:**

**Current Award Start Date:** 29-SEP-95
**Current Award End Date:** 28-SEP-00
**P.O. Requested Start Date:** 30-NOV-99
**P.O. Requested End Date:** 28-SEP-00

**PR Type:** Incremental Funding

**Internal Coordinator(s):**
**Phone:**

**Instrument Type:** Grant
**Basis For Selection:** (baa)
**CBD Date:**

**Current Funding:**

| ACRN | APPN | SBHD | OBJ | PA RM | BCN | SA | AAA | TT | PAA | COST CODE | | AMOUNT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AF | 9700400 | WBBB | 000 | RA | 36 | 9 | 068342 | 2D | 000000 | R1103 | 000URIJ | $1,753,000.00 |

**FRC:** URIJ Expiration: 30-SEP-00

**Future Funding:**

| FY | FRC | NEG START DATE | AMOUNT |
|---|---|---|---|

**PR Status:** Committed

**Equipment Cost (Current Year):** $ .00

| | |
|---|---|
| **Cumulative Total Award Value:** | $10,450,000.00 |
| **Total Value of PR:** | $ 1,753,000.00 |
| **Increment Value:** | $ 1,753,000.00 |
| **Modification Negotiated Value:** | $ 1,184,805.00 |

**Short Work Statement**

The design, fabrication, and optimization of power switching devices will be investigated in materials having higher electric field breakdown strength than silicon. The work will be focused on two such materials: silicon carbide (SiC) and aluminum gallium nitride (AlGaN). Both theoretical and experimental studies will be carried out with the goal of developing manufacturable power switching devices that are far superior to those that are currently available.

**PR Number:** 98PR02984-01

FORD
12-16

**Previous PR Number:** 98PR02984-00
**Title:** Manufacturable Power Switching Devices

**Award Number:** N000149511302
**Modification Number:** P00004

**Short Contractor Code:** purd
**Size and Type of Business:** 1s
Nonprofit-Educ./Not Historically Black/State Controlled

**P.I. Name:** James Cooper
**Performer:** PURDUE RESEARCH FOUNDATION
HOVDE HALL THIRD FLOOR
WEST LAFAYETTE, IN 47907

**P.O. Name:** John Zolper
**P.O. Code:** 312
**P.O. Phone:** (703) 696-2611
**Point of Contact:** Zolper Robert
**Phone:** (303) 497-1194
**Grants Officer:**

**Current Award Start Date:** 29-SEP-95
**Current Award End Date:** 28-SEP-98
**P.O. Requested Start Date:** 15-JAN-98
**P.O. Requested End Date:** 29-NOV-98

**PR Type:** Option to be Incrementally Funded

**Internal Coordinator(s):**
**Phone:**

**Instrument Type:** Grant
**Basis For Selection:** (baa)
**CBD Date:**

**Current Funding:**

| ACRN | APPN | SBHD | OBJ | PA RM | BCN | SA | AAA | TT | PAA | COST CODE | | AMOUNT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AD | 9780400 | WBBB | 000 | RA | 35 | 3 | 068342 | 2D | 000000 | R1103 | 000URIJ | $337,000.00 |

**FRC:** URIJ Expiration: 30-SEP-98

**Future Funding:**

| FY | FRC | NEG START DATE | AMOUNT |
|---|---|---|---|
| 1999 | URIJ | 30-NOV-98 | $ 2,090,000.00 |
| 2000 | URIJ | 30-NOV-99 | $ 1,753,000.00 |

**PR Status:** Approved (Active)

**Equipment Cost (Current Year):** $ .00

| | |
|---|---|
| **Cumulative Total Award Value:** | $10,450,000.00 |
| **Total Value of PR:** | $ 337,000.00 |
| **Increment Value:** | $ 337,000.00 |
| **Modification Negotiated Value:** | $ 0.00 |

**Notes to Acquisition**
This PR is for the first two months of the options on this contract. It is being funded under FY98 funds and assumes the performers will receive a favorable review in the spring for approval of the full option years. This approval is expected based on work to date. The grantee should be formally notified that even though the first 2 months of the option are funded, this actions does not commit the DoD to fund the option in its entirety.

**Short Work Statement**
The design, fabrication, and optimization of power switching devices will be investigated in materials having higher electric field breakdown strength than silicon. The work will be focused on two such materials: silicon carbide (SiC) and aluminum gallium nitride (AlGaN). Both theoretical and experimental studies will be carried out with the goal of developing manufacturable power switching devices that are far superior to those that are currently available.

**BPS: Submission, Evaluation, Cost**
Other Direct Costs- Other proposed direct costs (such as supplies, equipment, ADP, travel, etc.) are reasonable and necessary for accomplishing the research project. I have reviewed and accepted the proposed budget subject to the grant/contracting officer's verification of rates in indirect costs. Where changes to the original budget were necessary I have had the principal investigator submit a revised budget through official university channels and that revised budget is enclosed. The proposal appears to be fair, reasonable, in the interest of the government, and is consistent with other previous and current efforts of this nature.

**BPS: Submission, Evaluation, Cost**
This proposal was received and evaluated in accordance with the DoD Multidisciplinary Research Program of the University Research Initiative announcement of 12 December 1994 published in the COMMERCE BUSINESS DAILY. Grant award is recommended based on evaluation of the proposal in accordance with the broad agency announcement. Financial Considerations: Labor - The proposed quantities and types of labor (including any consultants and labor provided by subgrantee) are reasonable and necessary for accomplishing the research project. The proposed labor rates are in line with standard academic or industrial practice for research of this type. Any consulting at a rate in excess of $500.00 per day is justified in the "Additional Consultant Information" text item.

**Equipment Justification**
There is no equipment purchase planned under this increment.

**Extended Work Statement**
The extended work statement as provided in the proposal is hereby incorporated by reference.

**PR Number:** 98PR02984-00

**Previous PR Number:** 97PR03362-00
**Title:** Manufacturable Power Switching Devices

**Award Number:** N000149511302
**Modification Number:** P00003

**Short Contractor Code:** purd
**Size and Type of Business:** 1s
Nonprofit-Educ./Not Historically Black/State Controlled

**P.I. Name:** James Cooper
**Performer:** PURDUE RESEARCH FOUNDATION
HOVDE HALL THIRD FLOOR
WEST LAFAYETTE, IN 47907

**P.O. Name:** John Zolper
**P.O. Code:** 312
**P.O. Phone:** (703) 696-2611
**Point of Contact:** Zolper Chanley Kim
**Phone:** (619) 594-2511
**Grants Officer:** Arlisa Tracey

**Current Award Start Date:** 29-SEP-95
**Current Award End Date:** 28-SEP-98
**P.O. Requested Start Date:** 30-NOV-97
**P.O. Requested End Date:** 28-SEP-98

**PR Type:** Incremental Funding

**Internal Coordinator(s):**
**Phone:**

**Instrument Type:** Grant
**Basis For Selection:** (baa)
**CBD Date:**

**Current Funding:**

| ACRN | APPN | SBHD | OBJ | PA RM BCN | SA | AAA | TT | PAA | COST CODE | AMOUNT |
|---|---|---|---|---|---|---|---|---|---|---|
| AD | 9780400 | WBBB | 000 | RA 35 | 3 | 068342 | 2D | 000000 | R1103 000URIJ | $1,734,667.00 |

**FRC:** URIJ Expiration: 30-SEP-98

**Future Funding:**

| FY | FRC | NEG START DATE | AMOUNT |
|---|---|---|---|
| 2000 | URIJ | 01-NOV-99 | $ 1,753,000.00 |
| 1998 | URIJ | | $ 337,000.00 |
| 1999 | URIJ | | $ 2,090,000.00 |

**PR Status:** Approved (Active)

**Equipment Cost (Current Year):** $ .00

| | |
|---|---|
| **Cumulative Total Award Value:** | $10,450,000.00 |
| **Total Value of PR:** | $ 1,734,667.00 |
| **Increment Value:** | $ 1,734,667.00 |
| **Modification Negotiated Value:** | $ 3,216,998.00 |

**Short Work Statement**

The design, fabrication, and optimization of power switching devices will be investigated in materials having higher electric field breakdown strength than silicon. The work will be focused on two such materials: silicon carbide (SiC) and aluminum gallium nitride (AlGaN). Both theoretical and experimental studies will be carried out with the goal of developing manufacturable power switching devices that are far superior to those that are currently available.

**BPS: Submission, Evaluation, Cost**

Other Direct Costs- Other proposed direct costs (such as supplies, equipment, ADP, travel, etc.) are reasonable and necessary for accomplishing the research project. I have reviewed and accepted the proposed budget subject to the grant/contracting officer's verification of rates in indirect costs. Where changes to the original budget were necessary I have had the principal investigator submit a revised budget through official university channels and that revised budget is enclosed. The proposal appears to be fair, reasonable, in the interest of the government, and is consistent with other previous and current efforts of this nature.

**BPS: Submission, Evaluation, Cost**

This proposal was received and evaluated in accordance with the DoD Multidisciplinary Research Program of the University Research Initiative announcement of 12 December 1994 published in the COMMERCE BUSINESS DAILY. Grant award is recommended based on evaluation of the proposal in accordance with the broad agency announcement. Financial Considerations: Labor - The proposed quantities and types of labor (including any consultants and labor provided by subgrantee) are reasonable and necessary for accomplishing the research project. The proposed labor rates are in line with standard academic or industrial practice for research of this type. Any consulting at a rate in excess of $500.00 per day is justified in the "Additional Consultant Information" text item.

**Equipment Justification**

The equipment purchased under this contract is reasonable and needed for the proposed research.

**Extended Work Statement**

The extended work statement as provided in the proposal is hereby incorporated by reference.

**PR Number:** 97PR03362-00

**Previous PR Number:** 96PR05125-00
**Title:** Manufacturable Power Switching Devices

**Award Number:** N000149511302
**Modification Number:** P00002
**Short Contractor Code:** purd
**Size and Type of Business:** 1s
Nonprofit-Educ./Not Historically Black/State Controlled

**P.I. Name:** James Cooper
**Performer:** PURDUE RESEARCH FOUNDATION
HOVDE HALL THIRD FLOOR
WEST LAFAYETTE, IN 47907

**P.O. Name:** Alvin Goodman
**P.O. Code:** 312
**P.O. Phone:** (703) 696-4845
**Point of Contact:** Thomas David
**Phone:** (608) 262-5111

**Current Award Start Date:** 29-SEP-95
**Current Award End Date:** 28-SEP-98
**P.O. Requested Start Date:** 30-DEC-96
**P.O. Requested End Date:** 28-SEP-98

**PR Type:** Incremental Funding

**Internal Coordinator(s):** Lambert McCullough **Phone:** (703) 696-2601
George Campisi (703) 696-2578
Colin Wood (703) 696-4202

**Instrument Type:** Grant
**Basis For Selection:** (baa)
**CBD Date:**

**Current Funding:**

| ACRN | APPN | SBHD | OBJ | PA RM | BCN | SA | AAA | TT | PAA | COST CODE | AMOUNT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AC | 9770400 | WBBB | 000 | RA | 35 | 3 | 068342 | 2D | 000000 | R1103 000URIJ | $1,393,333.00 |

**FRC:** URIJ Expiration: 30-SEP-98

**Future Funding:**

| FY | FRC | NEG START DATE | AMOUNT |
|---|---|---|---|
| 1998 | | 01-NOV-96 | $ 2,090,000.00 |
| 2000 | | 01-NOV-99 | $ 1,038,000.00 |
| 1998 | | | $ 0.00 |
| 1999 | | | $ 0.00 |

**PR Status:** Approved (Active)

**Equipment Cost (Current Year):** $ .00

| | |
|---|---|
| **Cumulative Total Award Value:** | $10,101,666.00 |
| **Total Value of PR:** | $ 1,393,333.00 |
| **Increment Value:** | $ 1,393,333.00 |
| **Modification Negotiated Value:** | $ 2,157,367.00 |

**Notes to Acquisition**
This is the third increment of funding for this MURI. Outyear funding is based on schedule supplied by Special Programs (Don Polk). Please correct outyear negotiated amounts and dates accordingly.

**Short Work Statement**
The design, fabrication, and optimization of power switching devices will be investigated in materials having higher electric field breakdown strength than silicon. The work will be focused on two such materials: silicon carbide (SiC) and aluminum gallium nitride (AlGaN). Both theoretical and experimental studies will be carried out with the goal of developing manufacturable power switching devices that are far superior to those that are currently available.

**BPS: Submission, Evaluation, Cost**
Other Direct Costs- Other proposed direct costs (such as supplies, equipment, ADP, travel, etc.) are reasonable and necessary for accomplishing the research project. I have reviewed and accepted the proposed budget subject to the grant/contracting officer's verification of rates in indirect costs. Where changes to the original budget were necessary I have had the principal investigator submit a revised budget through official university channels and that revised budget is enclosed. The proposal appears to be fair, reasonable, in the interest of the government, and is consistent with other previous and current efforts of this naturo.

**BPS: Submission, Evaluation, Cost**
This proposal was received and evaluated in accordance with the DoD Multidisciplinary Research Program of the University Research Initiative announcement of 12 December 1994 published in the COMMERCE BUSINESS DAILY. Grant award is recommended based on evaluation of the proposal in accordance with the broad agency announcement. Financial Considerations: Labor - The proposed quantities and types of labor (including any consultants and labor provided by subgrantee) are reasonable and necessary for accomplishing the research project. The proposed labor rates are in line with standard academic or industrial practice for research of this type. Any consulting at a rate in excess of $500.00 per day is justified in the "Additional Consultant Information" text item.

**BPS: Overall Merits**

This unique program is an integrated effort by four universities and the leading commercial supplier of wide-bandgap semiconductor material aimed at the development of practical, reliable, and manufacturable power switching devices having performance significantly greater than the ultimate theoretical performance of silicon devices. Such performance improvements can only be realized by fabricating power devices in a wide bandgap semiconductor such as SiC or AlGaN. These materials are in a relatively immature state of development compared to silicon, and much of the effort will be directed to materials growth, materials characterization, defect reduction, and fabrication technology development. Moreover, because of the unique electrical and thermal properties of these materials, the optimum power devices will possibly be quite different from comparable silicon devices. This program will answer many questions relating to wide bandgap power device development, and will open the way for commercial production of these devices.

**BPS: ONR Mission**

Hybrid propulsive systems consisting of a conventional heat engine (internal combustion, gas turbine, or nuclear reactor) combined with an electric power delivery system (consisting of a generator, battery, and motor) promise to revolutionize military vehicles as diverse as ships, aircraft, and tanks by giving the designer unprecedented flexibility in locating and optimizing the individual system components. Such systems offer increased affordability, stealth, system redundancy, efficiency, and performance compared to conventional propulsive systems. However, in order to control electric currents at the desired levels, the performance of electronic switching components must be improved beyond what is technically feasible with silicon technology. The wide bandgap power switching devices developed in this program will enable the implementation of power handling electronics for the "more-electric" vehicles of the future.

**BPS: Contractor Qualifications**

The proposed contractor provides the unique capabilities and experience of the principal investigator as described in the research proposal. The principal investigator would not be available through any other contractor.

**BPS: PI Qualifications**

The principal investigator is highly qualified to execute the proposed program based on previous experience, publications, and presentations as described in the proposal.

**Equipment Justification**

EQUIPMENT JUSTIFICATION The equipment listed on the budget page of this proposal and modified by letter of 27 February (modifications listed in this PR) will be used as described in the proposal. In the judgement of the Scientific Officer, the purchase of the listed equipment is necessary for expeditious pursuit of the proposed research. There is no economical or practical alternative to providing equipment to the Contractor, for the object of this procurement is to explore ideas submitted by the Principal Investigator and the work, as a practical matter, cannot be performed unless the Government provides property of the type listed in the proposal.

**Extended Work Statement**

The extended work statement as provided in the proposal is hereby incorporated by reference.

**PR Number:** 96PR05125-00

**Previous PR Number:** 1213017---01
**Title:** Manufacturable Power Switching Devices

**Award Number:** N000149511302
**Modification Number:** P00001
**Short Contractor Code:** purd
**Size and Type of Business:** 1s
Nonprofit-Educ./Not Historically Black/State Controlled

**P.I. Name:** James Cooper
**Performer:** PURDUE RESEARCH FOUNDATION
HOVDE HALL THIRD FLOOR
WEST LAFAYETTE, IN 47907

**P.O. Name:** Alvin Goodman
**P.O. Code:** 312
**P.O. Phone:** (703) 696-4845
**Point of Contact:** Seligman Stephanie
**Phone:** (301) 443-6170

**Current Award Start Date:** 29-SEP-95
**Current Award End Date:** 28-SEP-98
**P.O. Requested Start Date:** 01-MAY-96
**P.O. Requested End Date:** 28-SEP-98

**PR Type:** Incremental Funding

**Internal Coordinator:**
**Phone:**

**Instrument Type:** Grant
**Basis For Selection:** (baa) Broad Agency Announcement
**CBD Date:** 12-DEC-94

**Funding Information:**

| ACRN | APPN | SBHD | OBJ | PA RM | BCN | SA | AAA | TT | PAA | COST CODE | | AMOUNT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AB | 9760400 | WBBB | 000 | RA | 35 | 3 | 068342 | 2D | 000000 | R1103 | 000URIJ | $1,742,000.00 |

**FRC:** URIJ **Expiration:** 30-SEP-96

| | |
|---|---|
| **Equipment Cost (Current Year):** | $ 118,999.00 |
| **Cumulative Total Award Value:** | $10,450,000.00 |
| **Total Value of PR:** | $ 1,742,000.00 |
| **Increment Value:** | $ 1,742,000.00 |
| **Modification Negotiated Value:** | $13,007,644.00 |
| **Future Funding:** | $ 0.00 |

Notes to Acquisition
This is the second increment of funding for this MURI. The increment schedule and the equipment schedule been changed, but there is no change in the overall budget.

Short Work Statement
The design, fabrication, and optimization of power switching devices will be investigated in materials having higher electric field breakdown strength than silicon. The work will be focused on two such materials: silicon carbide (SiC) and aluminum gallium nitride (AlGaN). Both theoretical and experimental studies will be carried out with the goal of developing manufacturable power switching devices that are far superior to those that are currently available.

BPS: Submission, Evaluation, Cost
Other Direct Costs- Other proposed direct costs (such as supplies, equipment, ADP, travel, etc.) are reasonable and necessary for accomplishing the research project. I have reviewed and accepted the proposed budget subject to the grant/contracting officer's verification of rates in indirect costs. Where changes to the original budget were necessary I have had the principal investigator submit a revised budget through official university channels and that revised budget is enclosed. The proposal appears to be fair, reasonable, in the interest of the government, and is consistent with other previous and current efforts of this nature.

BPS: Submission, Evaluation, Cost
This proposal was received and evaluated in accordance with the DoD Multidisciplinary Research Program of the University Research Initiative announcement of 12 December 1994 published in the COMMERCE BUSINESS DAILY. Grant award is recommended based on evaluation of the proposal in accordance with the broad agency announcement. Financial Considerations: Labor - The proposed quantities and types of labor (including any consultants and labor provided by subgrantee) are reasonable and necessary for accomplishing the research project. The proposed labor rates are in line with standard academic or industrial practice for research of this type. Any consulting at a rate in excess of $500.00 per day is justified in the "Additional Consultant Information" text item.

BPS: Overall Merits
This unique program is an integrated effort by four universities and the leading commercial supplier of wide-bandgap semiconductor material aimed at the development of practical, reliable, and manufacturable power switching devices having performance significantly greater than the ultimate theoretical performance of silicon devices. Such performance improvements can only be realized by fabricating power devices in a wide bandgap semiconductor such as SiC or AlGaN. These materials are in a relatively immature state of development compared to silicon, and much of the effort will be directed to materials

growth, materials characterization, defect reduction, and fabrication technology development. Moreover, because of the unique electrical and thermal properties of these materials, the optimum power devices will possibly be quite different from comparable silicon devices. This program will answer many questions relating to wide bandgap power device development, and will open the way for commercial production of these devices.

**BPS: ONR Mission**

Hybrid propulsive systems consisting of a conventional heat engine (internal combustion, gas turbine, or nuclear reactor) combined with an electric power delivery system (consisting of a generator, battery, and motor) promise to revolutionize military vehicles as diverse as ships, aircraft, and tanks by giving the designer unprecedented flexibility in locating and optimizing the individual system components. Such systems offer increased affordability, stealth, system redundancy, efficiency, and performance compared to conventional propulsive systems. However, in order to control electric currents at the desired levels, the performance of electronic switching components must be improved beyond what is technically feasible with silicon technology. The wide bandgap power switching devices developed in this program will enable the implementation of power handling electronics for the "more-electric" vehicles of the future.

**BPS: Contractor Qualifications**

The proposed contractor provides the unique capabilities and experience of the principal investigator as described in the research proposal. The principal investigator would not be available through any other contractor.

**BPS: PI Qualifications**

The principal investigator is highly qualified to execute the proposed program based on previous experience, publications, and presentations as described in the proposal.

**Equipment Justification**

EQUIPMENT JUSTIFICATION The equipment listed on the budget page of this proposal and modified by letter of 27 February (modifications listed in this PR) will be used as described in the proposal. In the judgement of the Scientific Officer, the purchase of the listed equipment is necessary for expeditious pursuit of the proposed research. There is no economical or practical alternative to providing equipment to the Contractor, for the object of this procurement is to explore ideas submitted by the Principal Investigator and the work, as a practical matter, cannot be performed unless the Government provides property of the type listed in the proposal.

Extended Work Statement

The extended work statement as provided in the proposal is hereby incorporated by reference.

not original sign but included otherwise A?

R & T PROJECT CODE 1213017---01 BASIC PREV R & T PROJECT CODE
PR SUBMISSION DATE 26 JUL 1995 DATE CONTRACT RECORD WRITTEN 26 JUL 1995
CONTRACT NUMBER CONTRACT MOD NUMBER
START DATE OF CURRENT CONTRACT 29 SEP 1995 END DATE 28 SEP 2000
REQUESTED START DATE 29 SEP 1995 END DATE 28 SEP 2000
NEGOTIATED START DATE 29 SEP 1995

CONTRACTOR NAME PURDUE RESEARCH FOUNDATION
SHORT CONTRACTOR CODE purd SIZE AND TYPE BUSINESS CODE 1s
CONTRACTOR STREET HOVDE HALL THIRD FLOOR
CONTRACTOR CITY WEST LAFAYETTE
CONTRACTOR STATE IN CONTRACTOR ZIP CODE 47907
REP CHANDREA LIGHTFOOT PH 317 494 1077

PR TYPE CODE(1) ne INSTRUMENT TYPE CODE grt
(2) op BASIS FOR SELECTION baa
(3) if EQUIPMENT TITLE con

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BRANCH HEAD APPROVAL OF SOURCE JUST./RFP DATE 8/1
BRANCH HEAD COMMENTS ON SOURCE JUSTIFICATIONS

SECTION LEADER USERID McCallum SECTION LEADER CODE , , .
SECTION LEADER NAME
DATE SECTION LEADER ASSIGNED ASSIGN WEIGHT

NEGOTIATOR USERID Coleman NEGOTIATOR CODE
NEGOTIATOR NAME , , .
DATE NEGOTIATOR ASSIGNED
PREVIOUS NEGOTIATOR NAME , .
PCO USERID NAME 6964845 CODE
S.O. NAME Goodman ,Alvin ,M .
S.O. USERID goodman4 S.O. CODE 312

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TOTAL CUMULATIVE VALUE OF CURRENT CONTRACT 0.00
TOTAL OBLIGATED FUNDING ON CURRENT CONTRACT 0.00
PREV NEG INCREMENTAL FUNDS PROVIDED BY THIS PR 0.00
NEW FUNDS BEING NEGOTIATED INTO CURRENT CONTRACT ~~10450000.00~~
CURRENTLY NEGOTIATED NEW FUNDS PROVIDED BY THIS PR 1400000.00
TOTAL EXPECTED TO BE OBLIGATED ON FUTURE ACTIONS ~~90~~50000.00

| FRC | PROGRAM YEAR | FUNDS INCREMENT | FS | FUNDS DUE DATE | ACRN | CSS FUNDS |
|---|---|---|---|---|---|---|
| urij | 1995 | 1400000.00 | a | 29 SEP 1995 | | 0.00 |
| | 1996 | 690000.00 | | 01 MAY 1996 | | 0.00 |
| | 1997 | 2090000.00 | | 01 OCT 1996 | | 0.00 |
| | 1998 | 2090000.00 | | 01 OCT 1997 | | 0.00 |
| | ~~1999~~ | ~~2090000.00~~ | | ~~01 OCT 1998~~ | | ~~0.00~~ |
| | ~~2000~~ | ~~2090000.00~~ | | 01 OCT 1999 | | ~~0.00~~ |
| | | 0.00 | | | | 0.00 |
| | | 0.00 | | | | 0.00 |
| | | 0.00 | | | | 0.00 |
| | | 0.00 | | | | 0.00 |

1498 TITLE (u)Manufacturable Power Switching Devices

REPORTS FREQUENCY CODE arq

PI NAME James A Cooper
PI TELEPHONE (317) 494 3514 EXT

CONTRACT PROPOSAL/REQUISTION NUMBER

ONR PROPSOAL NUMBER 95412--0263

PATENTS INTEREST CODE

CLASSIFICATION DD 254 DATE OF DD 254

Notes to 600:
This is the initial increment of the first-year funding for a new MURI. Please negotiate for a three-year grant with a two-year option continuation. Certifications, revised budget, BAA submission, and modified start date documents have all been obtained and are included with the proposal.

Short Work Statement:
The design, fabrication, and optimization of power switching devices will be investigated in materials having higher electric field breakdown strength than silicon. The work will be focused on two such materials: silicon carbide (SiC) and aluminum gallium nitride (AlGaN). Both theoretical and experimental studies will be carried out with the goal of developing manufacturable power switching devices that are far superior to those that are currently available.

Extended Work Statement:
The extended work statement as provided in the proposal is hereby incorporated by reference.

BPS:Submission,Eval,Cost/JA:Desc:
This proposal was received and evaluated in accordance with the DoD Multidisciplinary Research Program of the University Research Initiative announcement of 12 December 1994 published in the COMMERCE BUSINESS DAILY. Grant award is recommended based on evaluation of the proposal in accordance with the broad agency announcement.

Financial Considerations:

Labor -
The proposed quantities and types of labor (including any consultants and labor provided by subgrantee) are reasonable and necessary for accomplishing the research project.
The proposed labor rates are in line with standard academic or industrial practice for research of this type.
Any consulting at a rate in excess of $500.00 per day is justified in the "Additional Consultant Information" text item.

Other Direct Costs-

Other proposed direct costs (such as supplies, equipment, ADP, travel, etc.) are reasonable and necessary for accomplishing the research project.

I have reviewed and accepted the proposed budget subject to the grant/contracting officer's verification of rates in indirect costs. Where changes to the original budget were necessary I have had the principal investigator submit a revised budget through official university channels and that revised budget is enclosed. The proposal appears to be fair, reasonable, in the interest of the government, and is consistent with other previous and current efforts of this nature.

BPS:Overall Merits/JA:Contr Quals:
This unique program is an integrated effort by four universities and the leading commercial supplier of wide-bandgap semiconductor material aimed at the development of practical, reliable, and manufacturable power switching devices having performance significantly greater than the ultimate theoretical performance of silicon devices. Such performance improvements can only be realized by fabricating power devices in a wide bandgap semiconductor such as SiC or AlGaN. These materials are in a relatively immature state of development compared to silicon, and much of the effort will be directed to materials growth, materials characterization, defect reduction, and fabrication technology development. Moreover, because of the unique electrical and thermal properties of these materials, the optimum power devices will possibly be quite different from comparable silicon devices. This program will answer many questions relating to wide bandgap power device development, and will open the way for commercial production of these devices.

BPS:ONR Mission/JA:Enhance Comp:
Hybrid propulsive systems consisting of a conventional heat engine (internal combustion, gas turbine, or nuclear reactor) combined with an electric power delivery system (consisting of a generator, battery, and motor) promise to revolutionize military vehicles as diverse as ships, aircraft, and tanks by giving the designer unprecedented flexibility in locating and optimizing the individual system components. Such systems offer increased affordability, stealth, system redundancy, efficiency, and performance compared to conventional propulsive systems. However, in order to control electric currents at the desired levels, the performance of electronic switching components must be improved beyond what is technically feasible with silicon technology. The wide bandgap power switching devices developed in this program will enable the implementation of power handling electronics for the "more-electric" vehicles of the future.

BPS:Contr Quals/JA:Noncomp Justfctn:
The proposed contractor provides the unique capabilities and experience of the principal investigator as described in the research proposal. The principal investigator would not be available through any other contractor.

BPS:PI Quals/JA:Improve Comp:
The principal investigator is highly qualified to execute the proposed program based on previous experience, publications, and presentations as described in the proposal.

1498 Technical Objective:
(u) The objectives of this program are to develop (i) devices that will

exhibit performance significantly better than the ultimate theoretical limits of silicon devices, and (ii) the technology for practical, reliable, and manufacturable power switching devices based on the wide bandgap semiconductors SiC and AlGaN.

1498 Approach:
(u) Research will be conducted along several parallel paths. These include material growth, material characterization, defect reduction, device design, fabrication technology development, device fabrication, and device characterization. At the present time, materials and fabrication technologies are more advanced in SiC than in AlGaN, so the initial device development activities will be conducted in SiC. At the same time, research will be conducted to optimize the growth and fabrication procedures for AlGaN. Device development will expand into AlGaN as soon as feasible, based on progress in material and fabrication technology. Device research will encompass both bipolar and field-effect devices.

Accounting Classification

ACRN-FRC-PY-----APPN------SUBHD-OBJ-BCN-SA--AAA---TT--PAA----COST CODE-----PE--
urij 1995 9750400 .WBBB 025 RA359 0 068342 2D 61103D R11030009120 06011(
Funds Source Title: WHS1RDDA
Source for Initialization: 2197-049
Date Funds Expire: 30 SEP 1995

Stars Pr Number: N0001495PR24dy8

Contractor Information:
Short Contractor Code: purd
PURDUE RESEARCH FOUNDATION
DIVISION OF SPONSORED PROGRAMS
HOVDE HALL  THIRD FLOOR
WEST LAFAYETTE, IN 47907

Size & Type: 1s
Country: US
City Code: 82862
State Code: 18
Duns Code: 07172054E
DLA Milscap Code: 4B877
Payment Dodaad Code: N00179
ACO Milscap Code: N62880
Cognizant Audit Agency: HS05
TIN: 351052049
PTIN:
Institution Code: 001825
Use EFT: No

GRANT CLEARANCE
R&T Project Code: 1213017---01
Unclassified

CLEARANCE MEMORANDUM
GRANTS WITH EDUCATIONAL AND NONPROFIT INSTITUTIONS

GRANTEE: GRANT NO: N00014-95-1-1302
PURDUE RESEARCH FOUNDATION
DIVISION OF SPONSORED PROGRAMS
HOVDE HALL THIRD FLOOR
WEST LAFAYETTE, IN 47907

AUTHORITY: (X) 10 USC 2358, as amended, and 31 U.S.C. 6304.

1. Selection Procedure: (X) Broad Agency Announcement:

This proposal was received in response to the ONR announcement of Multi disciplinary Research Program of the University Research Initiative published in the COMMERCE BUSINESS DAILY of 12 DEC 1994. The Scientific Officer recommends award based on evaluation of the proposal in accordance with the criteria set forth in the announcement.

2. Proposal Identification:
Title: Manufacturable Power Switching Devices
Number: DSP NO. Y165 Date: 07 MAR 1995 As revised: 10 JUL 1995

3. Principal Investigator: James A. Cooper

4. Instrument type: Domestic Research Grant

5. Description of Work: The Grantee's proposed work description is incorporated in the Grant by reference.

6. Analysis of Cost/Price:
A copy of the proposed budget is attached.

(a) The Scientific Officer has reviewed the quantities and types of labor, including consultants and subgrantee labor, and also the other direct cost items (such as travel, equipment, supplies, materials, ADP, etc.) and has determined them to be

appropriate for the proposed research.

(b) The Negotiator has reviewed the budget and determined that the other direct cost items are acceptable based on the following:

**SALARIES: (BASE: $(b) (4) OPTION: (b) (4))**

PERSONNEL: (BASE: (b) (4) OPTION: $(b) (4)
Proposed salaries, types of labor and number of hours for this project have been reviewed and accepted by the Program Officer. Qualifications for all Key Investigators for Purdue Research and the subawardee's are given in the Grant File.

GRAD REMISSION FEE: (BASE: $73,699.00, OPTION: $63,380.00)
The proposed rate is Purdue's current and usual customary rate applied to each graduate student.

**FRINGE BENEFITS: (BASE:$(b) (4) OPTION: $(b) (4)**

The fringe rate is based on university policy and properly applied to the salary of each employee.

**OTHER DIRECT COSTS: (BASE: $719,550.00 OPTION: $385,635.00)**

COMMUNICATIONS: (BASE: $6,243.00, OPTION: $4,590.00)
The proposed cost consists of estimated usage of telephone, fax, federal express, and postage expenses. The cost was based on historical costs of similar projects, and scaled to the number of faculty and graduate students, and subawardee's involved in this project

TRAVEL: (BASE: $46,581.00, OPTION: $29,831.00)
The Grantee's proposed travel is necessary for proper conduct of the research effort and the need to visit the subawardee's from time-to-time. The individual elements of travel are reasonable and in accordance with current university travel policy. The Grant file contains a breakdown of the number of trips, location, number of personnel, airfare, perdiem and individual expenses for each trip. The Grantee anticipates two foreign trips, which have been approved by the Program Officer.

PUBLICATION & DUPLICATION: (BASE: $18,730.00, OPTION: $13,768.00)
The proposed costs include publication costs (approx. $110/page) for technical journal articles and duplication cost of technical reports, the final report, and copying of other related technical papers. The department uses a key counter for general copying. The cost was based on historical costs of similar projects, and scaled to the number of faculty and graduate students involved in this project.

SUPPLIES & EXPENSES: (BASE: $228,997.00, OPTION: $172,446.00)
The proposed cost includes consumable and scientific supplies necessary to accomplish the research. Included are chemicals for cleaning; high purity metals (plantium, gold, etc); high purity gases (aragon, oxygen, SF-6, hydrogen, etc). These costs are estimated based on historical data from previous similar projects, number of graduate students per year, and the fraction of time in the lab. Generally it is estimated that from $5K to $10K per student per year is the average cost.

SCIENTIFIC EQUIPMENT: (BASE: $118,999.00, OPTION: $0.00)
The Grantee has provided a justification for the type of equipment needed for the project which is filed in the Grant file. In year one the cost of the LCR Meter is $15,125.00 and the Vaccum Annealing Furn. $29,317.00. The cost of the Micor Manipulator Probe Station is $34,557.00 and the Thermal Oxidation Tubes is $30,000.00 for the second year. The estimates for equipment and options were based on typical catalogs prices. The University will use competitive buying procedures established by University policy. Title to equipment will be vested with the Grantee.

SiC PURCHASES: (BASE: $300,00.00, OPTION: $165,000.00)
The proposed amount is for Silicone Carbonate Wafers (which is the basic element of this project) will be purchased from Cree Research(one of the only two companies that produce this product). Generally the cost per wafer is $2K each to $5K each for more specialized wafers. Cree has agreed to allow a 50% discount for this project and will cost share the remaining amount. The number of wafers estimated is for an estimated amount per the total number of graduate students for Purdue, Univ of Texas and Howard University.

UNIVERSITY OF TEXAS (BASE: $1,270,979.00 OPTION: $897,977.00)

SALARIES: (BASE: $(b) (4) , OPTION: $(b) (4)
The administrative assistant will devote 1/3 of effort to this project entirely to do the purchasing, accounting, billing, scheduling and other clerical functions. It is university policy for the departments to furnish clerical support in the Grant award.

GRAD REMISSION FEE: (BASE: $39,887.00, OPTION: $28,194.00)
The proposed rate is the University's current and usual customary rate applied to each graduate student which is calculated for each student based on a minimum of 9 credit hours for the spring and fall semester, 6 credit hours for the summer, and the standard partial tuition fee waiver.

FRINGE BENEFITS: (BASE: (b) (4) OPTION: (b) (4)
The fringe rate is based on university policy and properly applied to the salary of each employee. This cost is considered acceptable.

COMMUNICATIONS: (BASE: $999.00, OPTION: $723.00)
The proposed cost consists of estimated usage of telephone, fax, federal express, and postage expenses. The cost was based on historical costs of similar projects, and scaled to the number of faculty and graduate students involved in this project.

TRAVEL: (BASE: $20,481.00, OPTION: $14,354.00)
The Grantee's proposed travel is necessary for proper conduct of the research effort and the need to visit the Grantee and other subawardee's from time-to-time. The individual elements of travel are reasonable and in accordance with with current university travel policy. The Grant file contains a breakdown of the number of trips, location, number of personnel, airfare, perdiem and individual expenses for each trip.

PUBLICATION & DUPLICATION: (BASE: $6,122.00, OPTION: $4,295.00)
The proposed costs include publication costs (approx. $110/page) for technical journal articles; technical graphics; and duplication of technical reports and the final report. The cost is estimated on historical data of previous projects and scaled to match the number of faculty and students in this project.

SUPPLIES & EXPENSES: (BASE: $226,313.00, OPTION: $145,589.00)
The proposed cost includes general office consumable supplies necessary to accomplish the research. Scientific supplies include sapphire substrates, high purity gases, misorientated silicon wafers for growth experiments, high purity precious metals to make electrical contact to the materials, and high purity wet chemicals (acids and solvents for cleaning). The proposed items are expendable. The amounts quoted are based on catalog prices or established competitive market prices sold in substantial quantities to the general public.

PERMANENT EQUIPMENT: (BASE: $28,000.00, OPTION: $0.00)
The Grantee has provided a justification for the type of equipment needed for the project which is filed in the Grant file. The Grantee intends to purchase three equipment items in the first year, a Mass Flow Controller for $5,000.00; a Vaccum Pump for $15,000.00; and a Optical Dewar for $8,000.00. The estimates were based on current catalogs prices. The University will use competitive buying procedures established by University policy. Title to the property will be vested with the Grantee.

INDIRECT COST RATE: (BASE: (b) (4) OPTION: (b) (4)
The rate of (b) (4) is in accordance with current policy and is correctly applied to the proper base. The proposed cost is considered acceptable.

**CREE RESEARCH (BASE: $857,988.00 OPTION: $589,898.00)**

Cree Research is the only subawardee which will receive a contract as a subaward. Originally Cree Research submitted a subaward budget for $1,06,724.00 for the three base years and $ 680,564.00 for the two option years. Based on a comparison of the rates used with the attached audit report from DCAA the budget was reduced by $84,666.00 to reflect the current rates. The $84,666.00 was applied to the Purdue's revised budget to increase the number of graduate students and buy more scientific equipment.

Cree's current budget does not reflect the actual rates from the audit report since the last audit was approximately one year ago. At the recommendation of DCAA the budgetary data for the fiscal year ending 30 JUN 1995 or budged rate for FY'96 (information gathered 18 AUG 1995) was determined to be the fair and reasonable cost to the Government. A synopsis of each cost item is as

follows:

SALARIES: (BASE: $(b) (4), OPTION: (b) (4))
The proposed rates are the actual hourly rates of the personnel assigned to this project, as documented by DCAA, current payroll data and an employee offer sheet.

| | Pro-posed | DCAA Recom-mended | Nego-tiated |
|---|---|---|---|
| J. W. Palmour, PI: | (b) (4) | | |
| Calvin Carter, Jr, PM: | | | |
| P&T Technican: | | | |
| Ranbir Singh, Engineer: | | | |
| Doug Waltz, Device Scientist: | | | |

Based on the above the proposed salaries are accepted as proposed.

ESCALATION RATE: Each of the out-years is excalated at (b) (4) of the previous year's rate. This rate was used based on historical data and future expectations and is considered acceptable.

INDIRECT COSTS: (BASE: (b) (4) OPTION: $(b) (4))
Cree's indirect costs were accepted as proposed in the revised budget dated 30 AUG 1995. The rates initally recommended by DCAA and actuals for FY95 differ slightly. CREE revised rates were accepted based on the Contractor's having up-to-date budgetary data not yet available to DCAA.

| | Pro-posed | DCAA Recmd | FY'95 Actual | Negoti-ated |
|---|---|---|---|---|
| P&T and R&D Fringe Rates: | (b) (4) | | | |
| P&T Overhead: | | | | |
| Mfg Admin: | | | | |
| R&D Overhead: | | | | |
| G&A: | | | | |

CLEAN ROOM PROCESSING: (BASE: $150,000.00, OPTION: $100,000.00)
The cost is based on an estimated number of wafers per month, and the estimated number of processing steps by the usual standard cost per unit.

SERVICES: (BASE: $70,200.00, OPTION: $46,800.00)
Services for Ion Implantation, Poly Si Deposition and Deposited Oxide are competed. The cost includes the estimated total number of implants per year, total number of operations needed and the cost per implant. The cost is based on vendor quotes from vendors used on a regular basis.

SUPPLIES AND MATERIALS: (BASE: $268,140.00, OPTION: $89,380.00)
The cost for SiC wafers w/EPI is based on catalog pricing. Cree Research will charge back the cost of wafers Cree will use in this project for device fabrication experiments. The price for photomasks is based on current vendor quotes.

TRAVEL: (BASE: $27,442.00, OPTION: $19,848.00)
The Contractor's proposed travel is necessary for proper conduct of the research effort and the need to visit the Grantee and other subawardees from time-to-time. The individual elements of travel are reasonable and in accordance with with current university travel policy. The Grant file contains a breakdown of the number of trips, location, number of personnel, airfare, perdiem and individual expenses for each trip.

FACILITIES COST OF MONEY: (BASE: $20,581.00, OPTION: $11,548.00)
The contractor has proposed current factors applicable to the proper base in the calculated amount for COM.

COST SHARING: (BASE: $119,070.00, OPTION: $79,380.00)
Cree Research has agreed to cost share $119,070.00 for the three base years and $79,380 for the two optional years.

**RPI: (BASE: $600,001.00 OPTION: $380,086.00)**

SALARIES: (BASE: (b)(4) , OPTION: (b)(4)
The clerical assistant will be used for clerical assistance (preparation of technical and final reports, purchasing, accounting, billing, scheduling and other clerical functions). It is university policy for the departments to furnish clerical support in the Grant award solely for this project. The salary is based on a standard rate based on the total grant amount.

GRAD REMISSION FEE: (BASE: $101,160.00, OPTION: $74,280.00)
The proposed rate is the University's current and usual customary rate applied to each graduate student.

FRINGE BENEFITS: (BASE: (b) (4) OPTION: (b) (4)
The fringe rate of (b) (4) is in accordance with current fixed rates or prospective forward pricing rates and is correctly applied to the proper base. This cost is considered acceptable.

EQUIPMENT: (BASE: $43,000.00, OPTION: $0.00)
The Grantee has provided a breakdown and justification for the type of equipment needed for the project which is filed in the Grant file. Year 1 the Grantee will purchase a Parametric Analyzer for $125,000.00 and year two a Pulse Generator for $6,000.00; a CV Meter for $10,000.00, and a Personal Computer for $2,000.00. The estimates were based on current catalog prices. The University will use competitive buying procedures established by University policy. Title to the property will be vested with the University.

TRAVEL: (BASE: $7,182.00, OPTION: $6,528.00)
The Grantee's proposed travel is necessary for proper conduct of the research effort and the need to visit the Grantee and other seabird's from time-to-time. The individual elements of travel are reasonable and in accordance with with current university travel policy. The Grant file contains a breakdown of the number of trips, location, number of personnel, airfare, perdiem and individual expenses for each trip.

MATERIALS AND SUPPLIES: (BASE: $29,329.00, OPTION: $17,690.00)
The proposed cost includes consumable supplies necessary to accomplish the research. Items include probe tips, computer disks, office supplies, coping, toner, paper for technical papers and duplication expenses. The proposed items are expendable. The amounts quoted are based on catalog prices or established competitive market prices sold in substantial quantities to the general public.

PUBLICATION & DUPLICATION: (BASE: $3,091.00, OPTION: $2,219.00)
The proposed costs include publication costs (approx. $110/page) for technical journal articles and reprints of papers.

COMPUTER SERVICES: (BASE: $15,455.00, OPTION: $11,092.00)
RPI will do all computer simulation related to this project. The cost for computer simulation is the usual and customary charge for the university's computer center workstation fee for usage times the estimated number of hours.

COMMUNICATIONS: (BASE: $1,707.00, OPTION: $918.00)
The proposed cost consists of estimated usage of telephone, fax, federal express, and postage expenses. The cost was based on historical costs of similar projects, and scaled to the number of faculty and graduate students involved in this project.

SOFTWARE LICENSE:(BASE: $30,909.00, OPTION: $9,335.00)
The cost consists of the actual charges from the company which supplied the computer simulation programs.

INDIRECT COST RATE: (BASE: (b) (4) OPTION: (b) (4)
The rate of (b) (4) is in accordance with current policy and is correctly applied to the proper base.

COST SHARING: (BASE: $121,131.00, OPTION: $84,817.00)
RPI will contribute approximately 20% of their budget in cost sharing, approx $40K per year.

**HOWARD UNIVERSITY:(BASE: $749,307.00 OPTION: $479,421.00)**

SALARIES: (BASE: (b) (4) OPTION: (b) (4)

FRINGE BENEFITS: (BASE: (b) (4) OPTION: (b) (4)
The fringe rate of (b) (4) is in accordance with current fixed rates or prospective forward pricing rates and is correctly applied to the proper base. This cost is considered acceptable.

SUPPLIES: (BASE: $64,200.00, OPTION: $37,893.00)
The proposed cost includes consumable supplies necessary to accomplish the research. Items include high purity gases, silicon substrates, high purity wet chemicals, expendable replacement parts, gaskets, valves and tubing for the reactor, graphic subceptors and filaments. The proposed items are expendable. The amounts quoted are based on catalog prices or established competitive market prices sold in substantial quantities to the general public.

PUBLICATION & DUPLICATION: (BASE: $2,650.00, OPTION: $2,000.00)
The proposed costs include publication costs (approx. $110/page) for technical journal articles and reprints of papers.

TRAVEL: (BASE: $8,580.00, OPTION: $4,500.00)
The Grantee's proposed travel is necessary for proper conduct of

the research effort and the need to visit the Grantee and other subawardees from time-to-time. The individual elements of travel are reasonable and in accordance with with current university travel policy. The Grant file contains a breakdown of the number of trips, location, number of personnel, airfare, perdiem and individual expenses for each trip.

ANALYTICAL SERVICES (UNIV OF MD):
(BASE: $127,250.00, OPTION: $83,891.00)
This cost represents services provided by the Univ of MD for the use of a transmission electron microtrosity technique to check the quality of wafers, the hourly charge of the equipment, and the salary for the UMD graduate student who will do the analytical evaluations.

EQUIPMENT: (BASE: $95,000.00, OPTION: $0.00)
The Grantee has provided a breakdown and justification for the type of equipment needed for the project which is filed in the Grant file. The proposed budget provides for $95K in the first year for an Atomic Force Microscope. The cost is based on the same quote UMD obtained to purchase the same instrument. The University will use competitive buying procedures established by University policy. Title to the property will be vested with the University.

INDIRECT COST RATE: (BASE: (b) (4) , OPTION: (b) (4)
The rate of 63.0% is in accordance with current policy and is correctly applied to the proper base.

**INDIRECT COST RATE: (BASE:** (b) (4) **OPTION:** (b) (4)
Purdue's indirect cost rate of of (b) (4) is in accordance with current policy and is correctly applied to the proper base.

7. Other Negotiated Terms and Conditions:

New Grants:

| | | |
|---|---|---|
| A. | Negotiated Grant Value: | $6,270,000.00 |
| | Increment value, if applicable: | $1,400,000.00 |
| | Period covered by increment: | 29 SEP 1995 to 30 APR 1996. |
| B. | Period of Performance: | 29 SEP 1995 to 28 SEP 1998. |
| C. | Option Value: | $4,180,000.00 |
| | Option Period of Performance: | 29 SEP 1998 to 29 SEP 2000. |

8. Certifications:

The appropriate certifications have been submitted by the Grantee and are located in the grant file.

NEGOTIATIONS CONDUCTED WITH: Professor Jim Cooper
CONCLUDED ON :30 AUG 95 PHONE: (317)494-2514 V.
(317)494-6441 F.

9. Reasonableness:
In the opinion of the undersigned, the terms and conditions of this action appear to be fair, reasonable, and in the best interests of the Government.

(b) (6)

| Curtissa L. Coleman | 251 | (703) 696-4516 |
|---|---|---|
| GRANT NEGOTIATOR | CODE | TELEPHONE NUMBER |

# TOTAL BUDGET

| | | | | 8/95-7/96 | 8/96-7/97 | 8/97-7/98 | Sub-Total | 8/98-7/99 | 8/99-7/00 | Sub-Total | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A. Salaries and Wages | | | | | | | | | | | |
| 1. Senior Personnel | | | | | | | | | | | |
| J. Cooper | AY | 35% | | | | | | | | | $210,640 |
| | SS | 2.0 mns | | | | | | | | | $110,024 |
| M. Melloch | AY | 25% | | | | | | | | | $118,012 |
| | SS | 1.5 mns | | | | | | | | | $72,695 |
| J. Woodall | AY | 10% | | | | | | | | | $67,990 |
| | SS | 1.5 mns | | | | | | | | | $104,703 |
| J. Gray | AY | 5% | | | | | | | | | $3,658 |
| | SS | .5 mn | | | | | | | | | $3,805 |
| 2. Other Personnel | | | | | | | | | | | |
| P. Chin | FY | 25% | | | | | | | | | $43,448 |
| Grad Students | AY | 50% | (9) | | | | | | | | $691,122 |
| | SS | 3.0 mns | (9) | | | | | | | | $211,483 |
| Total Salaries & Wages | | | | $296,938 | $318,710 | $331,456 | $947,106 | $338,468 | $352,006 | $690,474 | $1,637,580 |
| Grad fee remission | | | | $20,799 | $25,260 | $27,840 | $73,699 | $30,260 | $33,120 | $63,380 | $137,079 |
| Total Compensation | | | | $317,737 | $343,970 | $359,098 | $1,020,805 | $368,728 | $385,126 | $753,854 | $1,774,659 |
| B. Fringe Benefits | | | | | | | | | | | |
| Total fringe benefits | | | | | | | | | | | $215,883 |
| C. Total Compensation and Fringes | | | | $360,333 | $385,843 | $402,648 | $1,148,824 | $411,884 | $429,834 | $841,718 | $1,990,542 |
| D. Non-Personnel direct costs | | | | | | | | | | | |
| Communications | | | | $2,000 | $2,080 | $2,163 | $6,243 | $2,250 | $2,340 | $4,590 | $10,833 |
| Travel - Domestic | | | | $11,000 | $13,520 | $14,061 | $38,581 | $14,623 | $15,208 | $29,831 | $68,412 |
| Travel - Foreign | | | | $4,000 | $0 | $4,000 | $8,000 | $0 | $0 | $0 | $8,000 |
| Publication & Duplication | | | | $6,000 | $6,240 | $6,490 | $18,730 | $6,749 | $7,019 | $13,768 | $32,498 |
| Supplies & Expenses | | | | $73,462 | $75,520 | $80,015 | $228,997 | $82,829 | $89,617 | $172,446 | $401,443 |
| Scientific Equipment | | | | $54,442 | $64,557 | $0 | $118,999 | $0 | $0 | $0 | $118,999 |
| SiC Purchases | | | | $100,000 | $100,000 | $100,000 | $300,000 | $100,000 | $65,000 | $165,000 | $465,000 |
| Sub-Contracts | | | | | | | | | | | |
| University of Texas | | | | $422,136 | $416,284 | $432,559 | $1,270,979 | $440,194 | $457,783 | $897,977 | $2,168,956 |
| Cree Research | | | | $275,962 | $286,113 | $295,913 | $857,988 | $295,478 | $294,420 | $589,898 | $1,447,886 |
| RPI | | | | $199,999 | $200,001 | $200,001 | $600,001 | $190,247 | $189,839 | $380,086 | $980,087 |
| Howard University | | | | $249,948 | $249,712 | $249,647 | $749,307 | $239,948 | $239,473 | $479,421 | $1,228,728 |
| Total non-personnel direct costs | | | | $1,398,949 | $1,414,027 | $1,384,849 | $4,197,825 | $1,372,318 | $1,360,699 | $2,733,017 | $6,930,842 |
| E. Total direct cost | | | | $1,759,282 | $1,799,870 | $1,787,497 | $5,346,649 | $1,784,202 | $1,790,533 | $3,574,735 | $8,921,384 |
| F. Indirect cost (b) (4) of MTD cost | | | | | | | | | | | $1,528,616 |
| G. Total cost | | | | $2,090,000 | $2,090,000 | $2,090,000 | $6,270,000 | $2,090,000 | $2,090,000 | $4,180,000 | $10,450,000 |

(b) (4)

(b) (4)

(b) (4)

(b) (4)

# Subcontract - University of Texas, Austin

| | 8/95-7/96 | 8/96-7/97 | 8/97-7/98 | Sub-Total | 8/98-7/99 | 8/99-7/00 | Sub-Total | TOTAL |
|---|---|---|---|---|---|---|---|---|
| A. Salaries and Wages | | | | | | | | |
| 1. Senior Personnel | | | | | | | | |
| Principle Investigators (partial summer salary) | [redacted] | | | | | | | $164,921 |
| 2. Other Personnel | | | | | | | | |
| Other Professionals | | | | | | | | |
| Eng. Assoc. @ 1/3 time | | | | | | | | $75,828 |
| Technician @ 1/3 time | | | | | | | | $100,437 |
| Graduate Assistants (4) | [redacted] | | | | | | | $299,022 |
| Adminstrative Asst. @ 1/3 time | | | | | | | | $61,333 |
| Total Salaries & Wages | $126,237 | $132,749 | $140,120 | $399,106 | $147,284 | $155,151 | $302,435 | $701,541 |
| Grad fee remission | $13,088 | $13,265 | $13,534 | $39,887 | $13,908 | $14,286 | $28,194 | $68,081 |
| Total Compensation | $139,325 | $146,014 | $153,654 | $438,993 | $161,192 | $169,437 | $330,629 | $769,622 |
| B. Fringe Benefits | | | | | | | | |
| Total fringe benefits | [redacted] | | | | | | | $256,955 |
| C. Total Compensation and Fringes | $185,731 | $194,664 | $204,954 | $585,369 | $215,066 | $226,142 | $441,208 | $1,026,577 |
| D. Non-Personnel direct costs | | | | | | | | |
| Communications | $333 | $333 | $333 | $999 | $320 | $403 | $723 | $1,722 |
| Travel - Domestic | $6,600 | $6,824 | $7,057 | $20,481 | $7,056 | $7,298 | $14,354 | $34,835 |
| Publication & Duplication | $2,000 | $2,040 | $2,082 | $6,122 | $2,125 | $2,170 | $4,295 | $10,417 |
| Supplies & Expenses | $71,612 | $77,171 | $77,530 | $226,313 | $72,588 | $73,001 | $145,589 | $371,902 |
| Permanent Equipment | $28,000 | $0 | $0 | $28,000 | $0 | $0 | $0 | $28,000 |
| Total non-personnel direct costs | $108,545 | $86,368 | $87,002 | $281,915 | $82,089 | $82,872 | $164,961 | $446,876 |
| E. Total direct cost | $294,276 | $281,052 | $291,956 | $867,284 | $297,155 | $309,014 | $606,169 | $1,473,453 |
| F. Indirect cost [redacted] of MTD cost | [redacted] | | | | | | | $695,503 |
| G. Total cost | $422,136 | $416,284 | $432,559 | $1,270,979 | $440,194 | $457,783 | $897,977 | $2,168,956 |

# Subcontract - Cree Research Incorporated

Total Base Contract Cost: $977,058 Cost of Base to Government: $857,988 Cost of Option to Government: $589,898

| | 8/95-7/96 | 8/96-7/97 | 8/97-7/98 | Sub-Total | 8/98-7/99 | 8/99-7/00 | Sub-Total | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 1. Clean Room Processing | $50,000 | $50,000 | $50,000 | $150,000 | $50,000 | $50,000 | $100,000 | $250,000 |
| 2. Package & Test Department Costs | | | | | | | | |
| Direct Labor Hours | 200 | 200 | 300 | | 300 | 300 | | |
| P & T Technicians ($11.25/hr) | $2,250 | $2,340 | $3,650 | $8,240 | $3,796 | $3,948 | $7,744 | $15,984 |
| Total P & T Labor | $2,250 | $2,340 | $3,650 | $8,240 | $3,796 | $3,948 | $7,744 | $15,984 |
| P & T Fringes ((b) (4) x Base) | $637 | $663 | $1,034 | $2,334 | $1,075 | $1,118 | $2,193 | $4,527 |
| P & T Overhead ((b) (4) x Base) | $3,474 | $3,613 | $5,636 | $12,723 | $5,861 | $6,096 | $11,957 | $24,680 |
| Total P & T Department Costs | $6,361 | $6,616 | $10,320 | $23,297 | $10,732 | $11,162 | $21,894 | $45,191 |
| 3. Mfg. Admin. Expenses = Total Direct Costs x (b) (4) | $8,460 | $8,498 | $9,054 | $26,012 | $9,116 | $9,180 | $32,144 | $58,156 |
| Total Mfg. Direct Costs + Mfg. Overhead | $64,821 | $65,114 | $69,374 | $199,309 | $69,848 | $70,342 | $154,038 | $353,347 |
| 4. R & D Department Costs | | | | | | | | |
| R & D Labor Hours | 200 | 200 | 200 | | 200 | 200 | | |
| PI - John W. Palm | (b) (4) | | | | | | | $51,044 |
| PM - Calvin Carter, | | | | | | | | $43,099 |
| Ranbir Singh | | | | | | | | $169,260 |
| Doug Waltz ( | | | | | | | | $45,810 |
| Total R & D Labor | $57,218 | $59,507 | $65,374 | $182,099 | $62,311 | $64,803 | $127,114 | $309,213 |
| R & D Fringe & Occupancy ((b) (4) x Base) | $16,210 | $16,858 | $18,520 | $51,588 | $17,653 | $18,359 | $36,012 | $87,600 |
| R & D Overhead ((b) (4) x Base) | $17,040 | $17,721 | $19,468 | $54,229 | $18,556 | $19,298 | $37,854 | $92,083 |
| Total R & D Department Costs | $90,468 | $94,086 | $103,362 | $287,916 | $98,520 | $102,460 | $200,980 | $488,896 |

# Subcontract - Cree Research Incorporated

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5. Services | | | | | | | | |
| Ion Implantation | $4,400 | $4,400 | $4,400 | $13,200 | $4,400 | $4,400 | $8,800 | $22,000 |
| Poly Si Deposition | $9,000 | $9,000 | $9,000 | $27,000 | $9,000 | $9,000 | $18,000 | $45,000 |
| Deposited Oxide | $10,000 | $10,000 | $10,000 | $30,000 | $10,000 | $10,000 | $20,000 | $50,000 |
| Total Services | $23,400 | $23,400 | $23,400 | $70,200 | $23,400 | $23,400 | $46,800 | $117,000 |
| 6. Supplies and Materials | | | | | | | | |
| a. SiC Wafers w/ Epi (Catalog Pricing) | $79,380 | $79,380 | $79,380 | $238,140 | $79,380 | $79,380 | $158,760 | $396,900 |
| b. Photomasks | $10,000 | $10,000 | $10,000 | $30,000 | $10,000 | $10,000 | $20,000 | $50,000 |
| Total Supplies and Materials | $89,380 | $89,380 | $89,380 | $268,140 | $89,380 | $89,380 | $178,760 | $446,900 |
| 7. Travel | $7,594 | $12,254 | $7,594 | $27,442 | $12,254 | $7,594 | $19,848 | $47,290 |
| Total Direct Cost and Overhead | $275,663 | $284,234 | $293,110 | $853,007 | $293,402 | $293,176 | $600,426 | $1,453,433 |
| 8. G & A Expenses | | | | | | | | |
| (b) (4) x Total Direct Cost) | $33,438 | $34,478 | $35,554 | $103,470 | $35,590 | $35,562 | $96,068 | $199,538 |
| Subtotal | $309,101 | $318,712 | $328,664 | $956,477 | $328,992 | $328,738 | $696,494 | $1,652,971 |
| 9. Facilities Capital Cost of Money | $6,551 | $7,091 | $6,939 | $20,581 | $6,176 | $5,372 | $11,548 | $32,129 |
| Total Cost | $315,652 | $325,803 | $335,603 | $977,058 | $335,168 | $334,110 | $708,042 | $1,685,100 |
| Less Cost Sharing | $39,690 | $39,690 | $39,690 | $119,070 | $39,690 | $39,690 | $79,380 | $198,450 |
| Cost to Government | $275,962 | $286,113 | $295,913 | $857,988 | $295,478 | $294,420 | $628,662 | $1,486,650 |

## Subcontract - Rensselaer Polytechnic Institute

| | 8/95-7/96 | 8/96-7/97 | 8/97-7/98 | Sub-Total | 8/98-7/99 | 8/99-7/00 | Sub-Total | TOTAL |
|---|---|---|---|---|---|---|---|---|
| A. Salaries and Wages | | | | | | | | |
| 1. Personnel | | | | | | | | |
| T. S. Chow AY 40% | (b) (4) | | | | | | | $135,616 |
| SS 1.5 mns | | | | | | | | $56,507 |
| Graduate Research Assistant(s) | | | | | | | | $138,798 |
| AY 50% | | | | | | | | $89,832 |
| SS 3 mns | | | | | | | | |
| Clerical Assistant | | | | | | | | $10,577 |
| Total Salaries & Wages | $81,235 | $83,677 | $86,196 | $251,108 | $88,777 | $91,445 | $180,222 | $431,330 |
| Grad fee remission | $32,400 | $33,720 | $35,040 | $101,160 | $36,420 | $37,860 | $74,280 | $175,440 |
| Total Compensation | $113,635 | $117,397 | $121,236 | $352,268 | $125,197 | $129,305 | $254,502 | $606,770 |
| B. Fringe Benefits (b) (4) | (b) (4) | | | | | | | $66,890 |
| C. Total Compensation and Fringes | $126,234 | $130,374 | $134,603 | $391,211 | $138,964 | $143,485 | $282,449 | $673,660 |
| D. Non-Personnel direct costs | | | | | | | | |
| Equipment | $25,000 | $18,000 | $0 | $43,000 | $0 | $0 | $0 | $43,000 |
| Travel - Domestic | $2,000 | $2,060 | $3,122 | $7,182 | $3,216 | $3,312 | $6,528 | $13,710 |
| Materials & Supplies | $6,774 | $7,785 | $14,770 | $29,329 | $10,865 | $6,825 | $17,690 | $47,019 |
| Publication Costs | $1,000 | $1,030 | $1,061 | $3,091 | $1,093 | $1,126 | $2,219 | $5,310 |
| Computer Services | $5,000 | $5,150 | $5,305 | $15,455 | $5,464 | $5,628 | $11,092 | $26,547 |
| Communications | $711 | $560 | $436 | $1,707 | $452 | $466 | $918 | $2,625 |
| Microfabrication Clean Room | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Software License | $10,000 | $10,300 | $10,609 | $30,909 | $4,635 | $4,700 | $9,335 | $40,244 |
| Total non-personnel direct costs | $50,485 | $44,885 | $35,303 | $130,673 | $25,725 | $22,057 | $47,782 | $178,455 |
| E. Total direct cost | $176,719 | $175,259 | $169,906 | $521,884 | $164,689 | $165,542 | $330,231 | $852,115 |
| F. Indirect cost (b) (4) of MTD cost | (b) (4) | | | | | | | $333,920 |
| G. Total cost | $239,594 | $240,373 | $241,165 | $721,132 | $232,231 | $232,672 | $464,903 | $1,186,035 |
| H. Cost Sharing | | | | | | | | |
| 10% AY in-kind of Chow Salary | $13,165 | $13,561 | $13,967 | $40,693 | $14,385 | $14,816 | $29,201 | $69,894 |
| ECSE Dept. 1/2 student tuition (in-kind) | $6,480 | $6,744 | $7,008 | $20,232 | $7,284 | $7,572 | $14,856 | $35,088 |
| 3% AY Chow Salary | $3,950 | $4,067 | $4,189 | $12,206 | $4,315 | $4,445 | $8,760 | $20,966 |
| School of Engineering | $8,000 | $8,000 | $8,000 | $24,000 | $8,000 | $8,000 | $16,000 | $40,000 |
| Dean of Faculty | $8,000 | $8,000 | $8,000 | $24,000 | $8,000 | $8,000 | $16,000 | $40,000 |
| Total Cost Sharing | $39,595 | $40,372 | $41,164 | $121,131 | $41,984 | $42,833 | $84,817 | $205,948 |
| I. Total Funds Requested | $199,999 | $200,001 | $200,001 | $600,001 | $190,247 | $189,839 | $380,086 | $980,087 |

# Subcontract - Howard University

| | 8/95-7/96 | 8/96-7/97 | 8/97-7/98 | Sub-Total | 8/98-7/99 | 8/99-7/00 | Sub-Total | TOTAL |
|---|---|---|---|---|---|---|---|---|
| A. Salaries and Wages | | | | | | | | |
| 1. Personnel | | | | | | | | |
| Michael G. Spencer | | | | | | | | $78,535 |
| Summer | | | | | | | | |
| Xiao Tang | | | | | | | | $67,911 |
| 1/4 Time | | | | | | | | |
| Kobchat Wongchotigul | | | | | | | | $40,621 |
| 1/4 Time | | | | | | | | |
| | | | | | | | | $106,000 |
| Post Doc | | | | | | | | |
| Total Salaries & Wages | $32,500 | $62,900 | $64,355 | $159,755 | $65,869 | $67,443 | $133,312 | $293,067 |
| B. Fringe Benefits | | | | | | | | $71,508 |
| (b) (4) & W) | | | | | | | | |
| C. Total Compensation and Fringes | $40,430 | $78,248 | $80,058 | $198,735 | $81,941 | $83,899 | $165,840 | $364,575 |
| D. Non-Personnel direct costs | | | | | | | | |
| Supplies | $14,200 | $26,000 | $24,000 | $64,200 | $20,009 | $17,884 | $37,893 | $102,093 |
| Publication Costs | $650 | $1,000 | $1,000 | $2,650 | $1,000 | $1,000 | $2,000 | $4,650 |
| Travel | $2,530 | $2,950 | $3,100 | $8,580 | $2,250 | $2,250 | $4,500 | $13,080 |
| Analytical Services (Univ of MD) | $37,250 | $45,000 | $45,000 | $127,250 | $42,008 | $41,883 | $83,891 | $211,141 |
| Equipment | $95,000 | $0 | $0 | $95,000 | $0 | $0 | $0 | $95,000 |
| Total non-personnel direct costs | $149,630 | $74,950 | $73,100 | $297,680 | $65,267 | $63,017 | $128,284 | $425,964 |
| E. Total direct cost | $190,060 | $153,198 | $153,158 | $496,415 | $147,208 | $146,916 | $294,124 | $790,539 |
| F. Indirect cost (b) (4) f MTD cost | | | | | | | | $438,189 |
| G. Total cost | $249,948 | $249,712 | $249,647 | $749,307 | $239,948 | $239,473 | $479,421 | $1,228,728 |